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COMPETITIVE WEAPON SYSTEMS
ACQUISITION: MYTHS AND FACTS

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March 1989

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This report summarizes the salient findings from a series of competition-related studies conducted for the Naval Air Systems Command Cost Analysis Division. It is unfortunate that many policy analyses, and many major acquisition decisions, were based on the myth that competing weapon systems should produce significant savings to the government. The fact is that dual source competition in major systems has resulted in additional costs to the government almost as often as it has produced savings. Theoretical explanations and empirical evidence are presented.

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COMPETITIVE WEAPON SYSTEMS ACQUISITION: MYTHS AND FACTS

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March 1989

COMPETITIVE WEAPON SYSTEMS ACQUISITION: MYTHS AND FACTS

ABSTRACT

After all the publicity about defense procurement scandals, the Administration, Congress, and the general public have been pushing to open defense acquisition to more competition. Congress enacted The Competition in Contracting Act of 1984. This report attempts to separate the myths from the facts of weapon system competition. It is unfortunate that many policy analyses, and many major acquisition decisions, were based on the myth that competing weapon systems should produce significant savings to the government. The fact is that dual source competition in major systems has resulted in additional costs to the government almost as often as it has produced savings. Theoretical explanations and empirical evidence are presented to shed some light on this major policy issue.

This report summarizes the salient findings from a series of competition-related studies which we conducted for the Naval Air Systems Command Cost Analysis Division. We found a common thread in these studies which has implications for major systems acquisition policy making and the direction of future competition-related policy studies.

COMPETITIVE WEAPON SYSTEMS ACQUISITION:

MYTHS AND FACTS

After publicity concerning $640 toilet covers, $436 hammers and other procurement problems, the U.S. Administration, Congress, and the general public began pushing to open defense acquisition to more competition. As a result, Congress enacted The Competition in Contracting Act of 1984[1]. Due to this strong legislative and political pressure, "Think Competition" has become a slogan in defense acquisition circles, and dual source procurement has been suggested as one means of obtaining additional competition.

The purpose of this report is to separate myths from facts in weapon system competition. It is unfortunate that many policy analyses, and many major acquisition decisions, were based on the myth that competing weapon systems would produce significant savings to the government.

The report is organized as follows: Section 1 describes the pressure faced by the Department of Defense (DoD) to increase the use of competition in procurement. Section 2 discusses the unique DoD market environment, while Section 3 reviews prior studies which demonstrate the paradox that competition has resulted in added net costs to the government as often as it has produced the desired net saving. Sections 4 and 5 present some theoretical and empirical data that explain the paradoxical findings. Section 6 summarizes myths and facts in weapon system competition and concludes with

directions for future study for acquisition policy and decision.

1. COMPETITION IN DEFENSE ACQUISITION

There is a deep-seated and historic belief that the best model for government procurement is solicitation of price offers from a maximum number of qualified sources. Indeed, there <u>are</u> many advantages to the government of competitive procurement if it is applied properly. Various imperatives for competition in defense procurement will be discussed in this section.

Since 1809, Federal statutes, regulations, and executive orders have consistently required that government procurement must, to the greatest possible extent, be made on a competitive basis. In 1965, the then Secretary of Defense Robert S. McNamara indicated to the Joint Economic Committee (Hearings on the Economic Impact of Federal Procurement) that the General Accounting Office (GAO) had evidence of dollar savings on the order of 25 percent or more when competition was introduced for reprocurement of an item which had a sole-source procurement history.[2] Since then, this 25 percent savings figure has been quoted repeatedly by defense policy makers and observers. In 1969, the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee called for vastly expanded use of competition for procuring all forms of Defense Department material.[3]

This position has been reaffirmed both by the current Administration and by Congress. The most recent legislation is

Public Law 98-369, which includes the Competition in Contracting Act of 1984. PL 98-369 stipulates the use of dual sourcing by DoD and civil agencies in procurement. The President's Blue Ribbon Commission on Defense Management (a.k.a. the Packard Commission) also strongly advocated the increased use of competition.[4] This drive toward competitive procurement is reflected in various internal DoD initiatives and programs.

2. DEFENSE MARKETS

Defense markets run the gamut from totally free competition to a DoD-created market with one buyer and one or two suppliers; from markets which provide many choices of product and product attributes to one in which a product exists only because the DoD has paid the price to create it. While a great majority of the 13 million annual procurement actions are conducted in a purely competitive fashion, the majority of defense procurement <u>dollars</u> have been spent in a market where the government is the only buyer and the number of potential suppliers is small.[5]

Competition in traditional markets arises when buyers and sellers are numerous and individually so unimportant in the market that their separate actions have no meaningful impact on market price. A great majority of DoD procurement <u>actions</u> are in such a market. However, the majority of procurement <u>dollars</u> are for major weapon systems which poses a unique problem.

For major systems, the government is the only buyer. It dictates the size of the market and the timing of demand. Additionally, these systems usually involve state-of-the-art technologies, and hence bear little relation to the infamous ubiquitous "widget" which is produced and sold in traditional competitive markets. Compounding these uncertainties to the supplier is the heavy investment needed to become a supplier. In this kind of environment, the availability of suppliers may be linked to the willingness of the government to absorb at least part of the risk, which could mean that the government must incur investment cost to develop a supplier in order to introduce a competitor. This is an element which is unique to the major defense systems market and is not well understood by those unfamiliar with the defense market. Lack of understanding of the uniqueness of defense market contributes to the allusion that competition in defense acquisition always produces lower prices to the government.

3. GAINS AND LOSSES FROM PRIOR DUAL SOURCE COMPETITION

Since McNamara's statement about the 25 percent savings from introducing a competitor, numerous studies had been conducted to examine the financial consequences of dual source competition. Earlier studies, with questionable methodologies, reported dramatic savings from introducing a competitor.[6] Despite their questionable methodologies, these studies were prominently cited as evidences of savings from introducing competition to weapon systems.[7] With

the improvement in research methodologies, studies conducted in recent years revealed that competition has resulted in <u>added</u> net costs almost as often as it has produced the desired net savings. A comprehensive survey of prior studies can be found in the literature[8] and, therefore, will not be repeated here. We will pursue the contradictory findings and provide additional insight on the inconsistency.

Although many dual-sourced weapon systems programs have been studied, we will examine only those with verifiable data. Our interests are not on predicting the size of dollar savings but on pursuing the paradoxical finding that dual source competition has resulted in added costs as well as net savings. Hopefully, these efforts will provide some leads for the direction of future policy analysis.

Table 1 lists seven dual-sourced programs which have been examined closely in several studies.[9] The program savings (losses) data were taken from earlier studies, and the amount of savings (losses) was calculated by comparing actual prices paid by the government after the program was dual sourced to the amount that would have been paid had the government continued sole source procurement.

We examined the time period during which each program was in the dual source competition mode, as shown in Column (3). The aerospace industry's capacity utilization rate during the dual source phase of each program is shown in Column (4). Note that the three programs realizing savings from dual sourcing were in the

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dual source procurement phase when the aerospace industry's capacity utilization rates were relatively low. On the other hand, the other four programs, which resulted in losses, were in the dual source procurement phase when the industry's capacity utilization rates were relatively high. It should be apparent to the reader that the likelihood of realizing savings or suffering losses from dual sourcing a major weapon system is related to the business environment of the industry.

[Insert Table 1 about here]

[Insert Figure 1 about here]

Figure 1 shows the same data in chronological order. From a historical perspective, the three dual-sourced programs which resulted in saving to the government (Bullpup, TOW, Rockeye) coincided roughly with either the post-Korean-war era or the post-Vietnam-war era. On the other hand, dual sourcing Sidewinder, MK-46, and Shillelagh resulted in additional cost to the government because they coincided with the height of the Vietnam war when the aerospace and the ordnance industries were at their busiest since WW II. It is clear that creating a second source as the "competitive" supplier does not always result in a competitive environment in an economic sense. Whether or not the government can realize the benefit of competition depends on the timing of dual sourcing. In the next two sections, we will provide additional insight to illuminate this point.

4. CONTRACTORS' FORWARD-PRICING STRATEGIES

The analysis in the preceding section suggests that contractors adjust their bid prices according to the business environment of their industry. Given the multitude of laws and regulations governing the government contractors' cost accounting and pricing, one might wonder how it is indeed possible to have varying levels of prices. To understand why this is possible, it is necessary to understand the forward-pricing system used in defense and other large civilian contracts.

Under the forward-pricing system, a bid price must be submitted well in advance on the often highly uncertain estimated cost to perform the contracted work. The uncertainty factor is particularly serious for defense contracts, since most involve state-of-the-art technologies. When the industry has ample idle capacity, such as in a post-war era, a firm may be so eager to compete for a contract that it will base its bid on an estimated cost figure which it may only have a small chance of achieving. Figure 2 depicts this decision scenario.[10] This hypothetical example assumes that the estimated cost to complete a contract ranges from the highly optimistic $50,000 (only 0.5% chance of achieving this cost figure) to the worst case scenario of $150,000. The top frame shows the estimated probability of occurrence of each cost figure. The bottom frame shows the cumulative probability of, or the chance to equal or better, a particular cost level.

[Insert Figure 2 about here]

Point **A** in the bottom frame of Figure 2 shows the estimated cost if the contractor is willing to accept a 50:50 chance. The corresponding cost estimate for the contract is approximately $98,000. The contractor may add another 10% as his profit target and submit a bid of $107,800 in the hope of winning the contract.

On the other hand, the contractors do not face any pressure to submit a competitive bids if business conditions in the industry improve and each firm has ample business opportunities. There are several reasons for this. For one, during an economic boom, a profit making firm is less likely to engage in price competition. This reduced willingness to compete in price would be further compounded if a contractor senses that other potential contractors also share this reduced willingness to compete. A booming economy also implies alternatives for the firm's production capacity. Sufficient profit opportunity must exist in order to justify capacity expansion, and, before the capacity can be expanded and made operational, existing projects must compete with each other for the limited capacity. Under all these circumstances, a contractor will not submit a bid unless he/she is highly confident that the estimated cost level can be equaled or bettered.

If the contractor desires a higher confidence level, say 75%, the estimated cost would be approximately $110,000, as shown in Point **B** in Figure 2. Adding a 10% profit target would bring the bid price to $121,000, a much higher bid compared to the $107,800 when the economy is not as good. Therefore, there is a close association between a contractor's bid price and the condition of

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the economy. This deduction is consistent with the empirical observation made in the preceding section that the potential for the government to realize the benefit of weapon system competition depends on the timing of dual sourcing.

5. STRUCTURAL DEFICIENCY OF DUAL SOURCE COMPETITION

Apart from the timing issue discussed above, there is a structural deficiency in the way a major weapon system can be procured competitively. Dual source competition allows the contractor and the government opportunities to exploit the market situation to the advantage of each party. The government's objective, as reflected in PL 98-369 and other policy directives cited earlier, is that competition will put competitive pressure on the supplier and result in a fair price to both parties. However, dual source competition also creates opportunities for the contractor to exploit. First, in return for the competitive market pressure with competitive bidding, the government gives up much of the regulatory authority it enjoys over verification of the contractor's cost and pricing data. Thus, it becomes easier for the contractor to obtain higher profits under a dual source competitive contract than under a sole source negotiated contract if the market environment allows it. Second, in order to maintain two sources of supply, it is necessary for the government to award a minimum sustaining quantity to the higher-priced competitor. Both of these factors put the government in a disadvantaged

position in dealing with the contractors. In this section, we will discuss various pricing strategies that can be used by the contractor to exploit the dual source competition situation.[11]

The Minimum Sustaining Rate

In a dual source competition environment, the lower-priced bidder is typically awarded the major portion of the annual quantity, but the higher bidder is also awarded a quantity that represents the minimum level of production the contractor requires to stay in production and remain viable. This guarantee, resulting from the government's desire to maintain two viable production sources, actually diminishes competitive pressures and puts the government in a disadvantaged position. Hence, there is no competitive incentive for the suppliers at the minimum sustaining quantity level, and the government can expect an inflated bid price from both of the suppliers at this level.

The Production Rate Effect

Due to the splitting of the production quantity between the two contractors, the government must forego some of the savings associated with cumulative production experience. The smaller production rate also means higher unit cost because neither contractor is able to fully realize the economies of scale in production. Therefore, the split award should result in higher production costs to either of the two contractors than if the entire year's production were awarded to the low bidder. The

argument for using dual source competition, of course, rests on the assumption that the loss of economies of scale and cumulative production experience should be more than offset by the smaller amount of profit the contractor would be forced to accept under competition. Therefore, it is usually suggested that the bid prices should be lower under a competitive environment, compared to a sole source acquisition, thus resulting in net savings to the Government.

Unequal Competitive Position Between Contractors

If the second supplier is established after the first supplier has had some production experience with the weapon system in question, the competitive position of the two contractors most likely will be unequal. Under this circumstance, the anticipated competitive pressure from dual sourcing may diminish, or even evaporate completely.

First of all, being the developer of the system and having had some production experience, the first supplier often enjoys a cost advantage over the new supplier. Other things being equal, the more experienced producer will have a lower production cost and can underbid the new supplier. This problem is compounded if the first supplier continues to win the majority of annual quantities in a dual award environment.

Second, there is a dilemma facing the government in establishing the second supply source. Being the only buyer in the major weapon system market, the government often has to provide financial

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resources to induce other contractors to establish the production facility for a particular weapon system. Expanding the capacity beyond the level needed clearly is not economical. But the combined production capacity of the two firms may far exceed the actual requirements if the second source is established at the same production capacity level as the original source. On the other hand, if the second source's production capacity is established at a level lower than the total government requirement, the second source would not be in a position to bid at the higher percentages of the annual requirement, thus creating a virtual monopoly for the original source at higher quantities.

Evidence of Contractor Price Gaming

The various scenarios discussed in this section reflect the structural deficiency of dual source competition, which presents many opportunities for contractors to submit inflated bid prices. This hypothesis is consistent with the forward-pricing strategy discussed earlier in providing the explanation for the paradoxical results of prior dual sourcing experience. To support our logical hypothesis, we will present an actual case which reflects the price gaming hypothesis discussed above.

Figure 3 shows the bid prices submitted by a contractor of a major weapon systems under the dual source competition environment. We have masked the identity of the program and contractor and the numerical values of the data in order to protect the proprietary information, but the relative scale of all prices is accurate.

[Insert Figure 3 about here]

The circle on the left in Figure 3 is the actual unit price awarded when the contractor was the sole source supplier. The dashed line going through this circle and extending downward to the right is the projected sole source price using the contractor's historical price-reduction curve.

In dual source competition, the government annually solicits bids from both suppliers for various quantity levels. The lower price bidder is awarded the larger share of the government's annual quantity requirements while the higher price bidder gets the smaller share, usually the minimum sustaining rate to keep the loser's plant active. The stars on the solid line represent the bid prices for the respective quantity levels (from 20% to 80% of total annual quantity at 10% increments, also known as the step-ladder bids) submitted by the contractor in the first year of dual source procurement. The triangles represent the second year bids.

For comparison, the dotted lines beneath the bid price curves represent the reasonable step-ladder bids. On a log-log graph such as Figure 3, these bids should form a downward sloping straight line to reflect the production rate economies for larger quantities. The dotted line should also intercept the dashed long-term price reduction curve to reflect the effect of learning from cumulative production experience. Comparing the step-ladder bids to the respective reference line, one can observe several irregularities in those annual bids.

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First, at the minimum sustaining rate (20%) level, the bids for both Year 1 and Year 2 are far above the reasonable bid line, indicating that the bid prices are too high at this quantity level. This reflects the point made earlier that, at the minimum sustaining rate level, there is no competitive pressure whatsoever and, no matter who wins the larger share, the other contractor will be a "happy loser."

Second, the bid prices went up for the 70% and 80% quantity levels. As the reasonable bid price curves show, the higher the quantity produced, the lower the unit price should be. Increasing the bids at high quantity levels is not economically justifiable and reflects the point made earlier that, if one contractor senses no competitive pressure from the other side at that quantity level, it can and will take advantage of the situation.

Another irregularity is that Year 2 bid prices were higher than those in Year 1. Since the data have been adjusted for inflation, it is reasonable to expect decreasing prices for subsequent years because of the learning curve phenomenon typical in the aerospace industry. These increasing prices are another example of price gaming which is made possible under dual source "competition".

6. CONCLUDING REMARKS

Due to the unique market structure, procurement of major defense systems has been done primarily on a sole source basis.

Current policy calls for expanded competition in procuring all forms of defense systems and material. Dual competition has been suggested as one means of obtaining competition in the major system procurement. However, extensive study of prior dual source competition experiences indicates that the results from this form of competition have been mixed.

In this report, we have provided some conceptual and empirical explanations for these paradoxical findings. Our attempt is to separate the myths from the facts of major weapon system competition:

Myth: Dual source procurement is a competitive procurement.

Fact: In economic theory, competition implies that there is a large number of suppliers and an individual supplier's action has no significant impact on the market. Dual source procurement is a classic case of duopoly which is, in fact, much closer to monopoly than to competition.

Myth: Dual source "competition" will force the suppliers to reduce their prices.

Fact: The primary condition under which the two suppliers in a defense industry duopoly would engage in price competition is when both are hungry for business, i.e., when the industry is in a slump. Even in this case, both suppliers can inflate the bid price at the minimum quantity without any penalty. Thus, at the minimum sustaining rate under the dual source procurement structure will always produce a "happy loser."

Myth: Dual sourcing a previously sole-sourced weapon system can produce savings on the order of 25% or more.

Fact: This myth was the direct result of McNamara's comment and has been quoted repeatedly by Washington decision makers in the past two decades. It is possible that this figure may be valid for a particular program, but there are many counter-examples. The size of savings and losses from dual sourcing varies. The fact is that the government must pay for introducing a second supply source in the form of initial investment, loss of economies of scale, and inflated prices for the minimum sustaining rate. Therefore, whether or not the government can realize savings from dual sourcing a major weapon system depends on the economic condition of the aerospace and ordnance industries. If the suppliers do engage in price competition, savings from the lower prices must be larger than the price the government paid for introducing the second source.

Understanding the myths and facts of major weapon system procurement is crucial in setting acquisition policies. Under a competitive bidding environment, as currently assumed by dual source procurement policy, the contractor can charge what the market will bear. On the other hand, under a monopoly environment, the contractor must substantiate all cost figures. Since dual source procurement is in reality closer to monopoly than to competition, regulations must be modified to eliminate those structural deficiencies of the current system.

In addition to separating myths from facts, our analyses of dual source competition policy also provide additional insights into contractors' pricing decision processes. We believe that these additional insights can shed some light on the direction of future policy studies. Clearly, the numerous attempts by the government to develop a method to quantify potential savings (as opposed to potential savings as well as losses) from dual source competition were misdirected. Our analysis shows that it is possible to determine the optimal timing to introduce a second source (or not to introduce it at all), but it would be futile to assume only savings result and then attempt to estimate the size of potential savings.

We believe that future policy research should focus on other viable alternatives to enhance competition at the major system level. These include major component breakout and multi-year contracting, among others.

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Table 1

Relationship Between Savings and Economic Environment

(1) Procurement Program	(2) Savings or (Loss) Due to Competition[#]	(3) Time Period in Dual Source Phase	(4) Average Capacity Utilization During Dual Source Phase
TOW Missile	26.0%	1971-75	63.5%
Rockeye Bomb	25.5	1972-73	70.9
Bullpup AGM-12B	18.7	1961-64	76.2
Shillelagh Missile	(4.7)	1968-69	87.0
Sparrow AIM-7F	(25.0)	1977-80	81.6
MK-46 Torpedo	(30.9)	1966-69	91.6
Sidewinder AIM-9D/G	(71.3)	1963-71	82.3

[#] From Beltramo and Jordan, 1982.

Figure 1
Capacity Utilization & Dual Sourcing
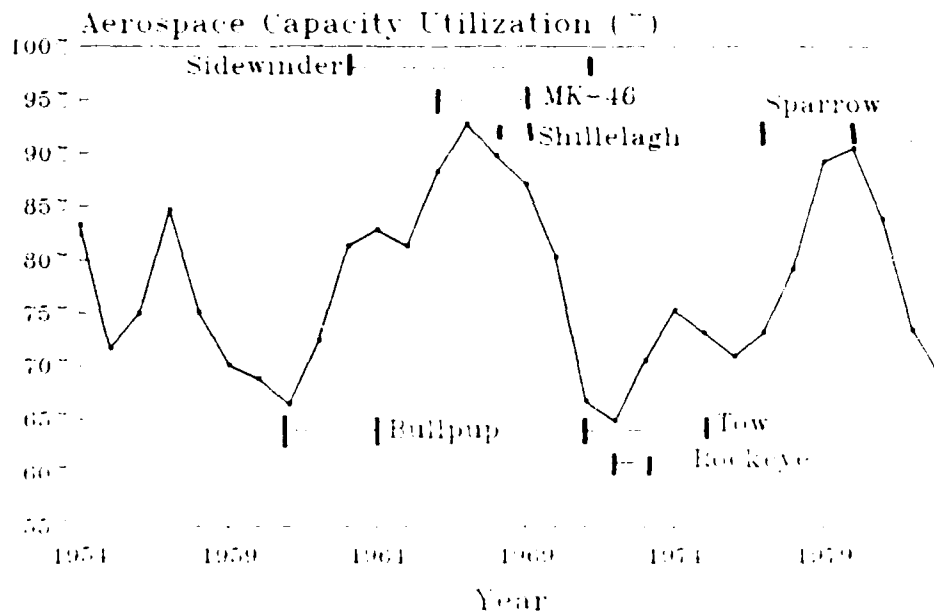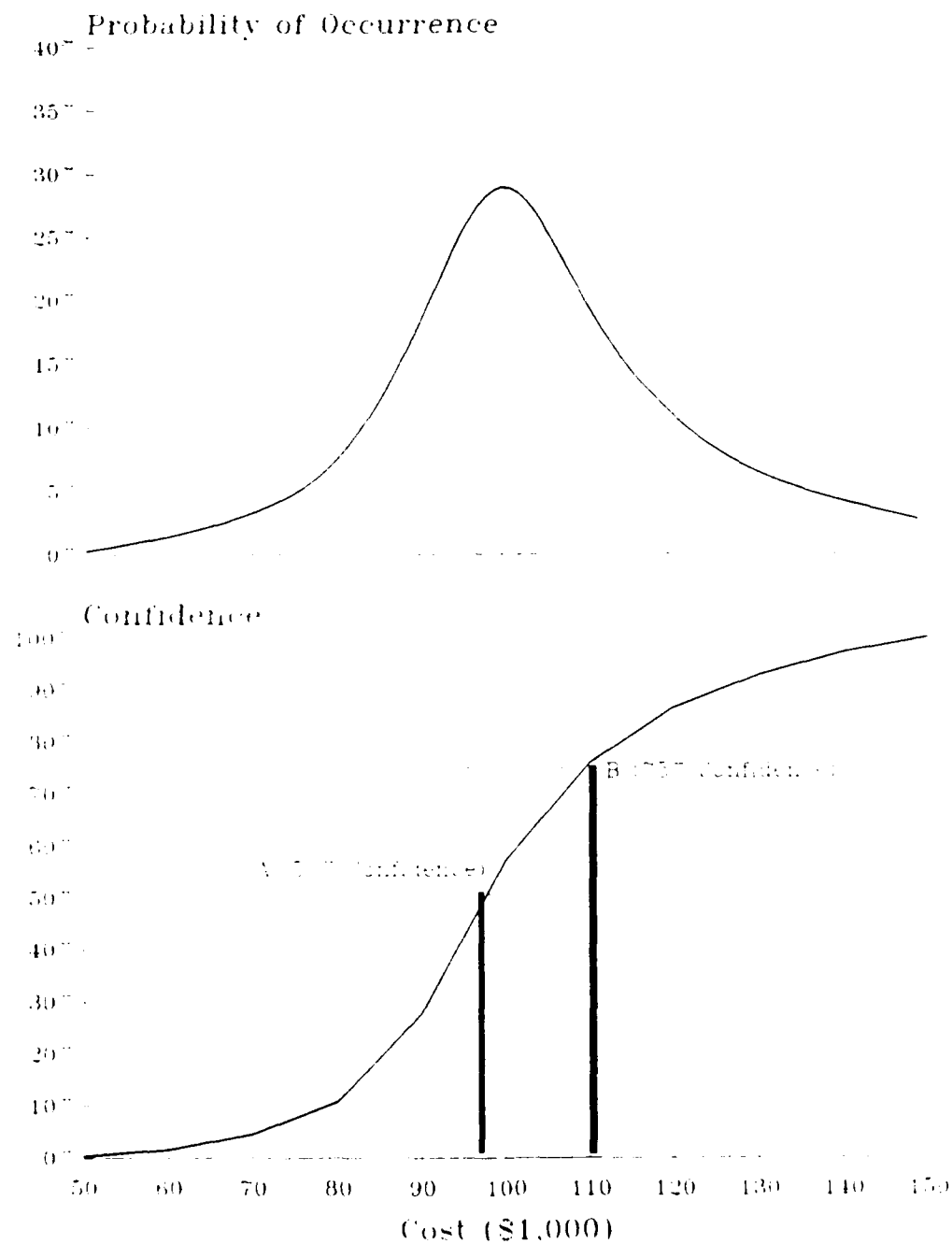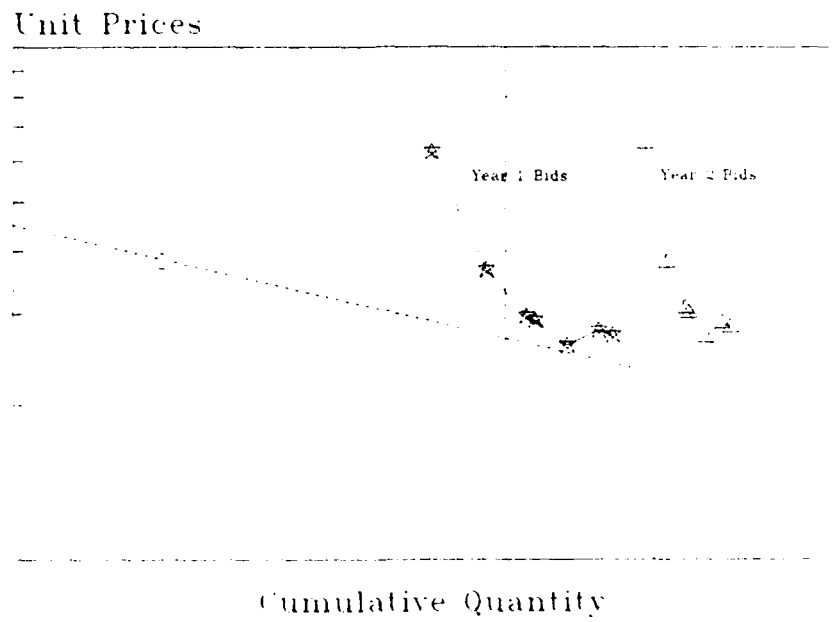
Figure 2
Cost Uncertainty & Bid Prices

Figure 3
Price Gaming Under Dual Sourcing

Unit Prices

Cumulative Quantity

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